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FORMATION OF AN INTRA-OROGENIC TRANSTENSIONAL BASIN: THE NEOGENE WAGRAIN BASIN IN THE EASTERN ALPS

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Tectonic setting

The Wagrain basin is an isolated intramontane Neogene basin located adjacent to metamorphic basement rocks of the Lower Austroalpine nappe complex of the Radstadt Mountains close to the northeastern edge of the Tauern metamorphic core complex (Fig. 1). It has been remapped in order to reveal basin formation mechanisms. The tectonic location of the Wagrain basin is along the combined Salzach-Enns/Mandling faults (Exner, 1996), to the north of the Mandling wedge, which represents a strike-slip duplex of Northern Calcareous Alps. Small lenses of reddish slate and metasandstone of likely Permian age at Wagrain may represent the western most outlier of the Mandling wedge. Furthermore, in contrast to other regions, the Graywacke zone there dips to ca. S. This suggests an antiformal geometry of the Graywacke zone and a close link to the formation and preservation of the Wagrain basin in a rollover structure.

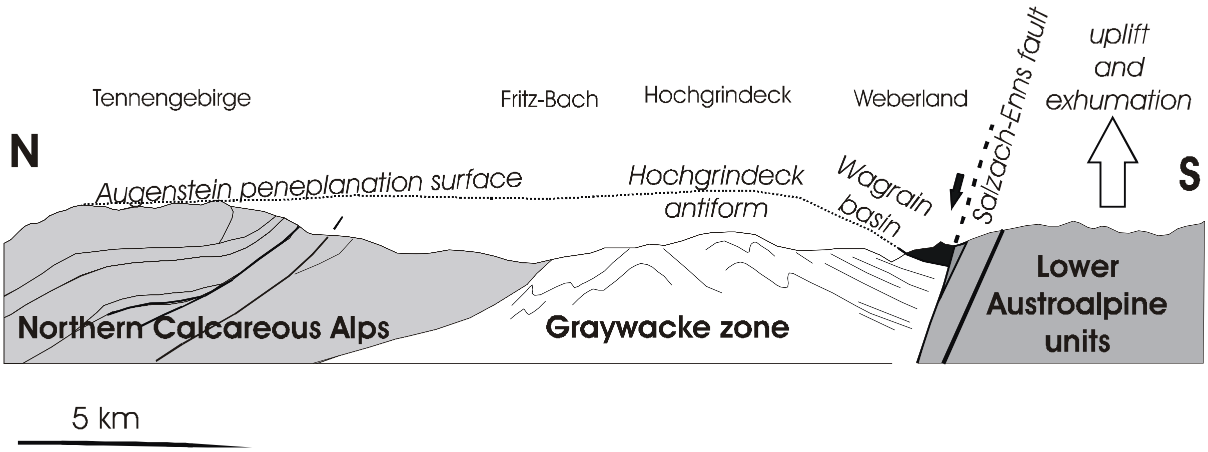

Fig. 1. Geological section from Tennengebirge to northeasternmost Hohe Tauern showing the preservation of the Wagrain basin within a rollover structure along the combined Salzach-Enns/Mandling faults.

Basin fill

Several lithofacies types follow in a vertical, respectively lateral, ca. ENE-trending, ca. 15 km long section. These include (Fig. 1):

(1) The basal ca. 3–8 meters thick **red conglomerate lithofacies** comprises reddish conglomerates (with boulders of ca. 30 centimeters size) and rare mica-rich sandstones.

(2) A minimum 40 meters thick **breccia lithofacies** N of Wagrain contains massive and thick beds with 1–3, maximum ca. 10 cms large, angular clasts.

(3) The ca. 80 m thick, **gray-brown, conglomerate lithofacies** is also polymict and includes variable, well-rounded or rounded clasts of increasing size ranging from a few centimeters at base to maximum 50 centimeters at top.

(4) The ca. 60 meters thick **alternating conglomerate/sandstone lithofacies** contains clasts with an average diameter of 1–4 centimeters. Associated sandstones are mica-rich and relatively well sorted and show scour and fill structures.

(5) The overlying, well bedded, ca. 30 m thick **gray-brown sandstone lithofacies** developed due to the disappearance of conglomerates. The individual beds are ca. 20 – 50 centimeters thick and display scour and fill structures.

(6) These sandstones grade upwards into 6–8 meters thick, internally massive 10 to 50 cms thick beds of dark grayish to locally black, **coaly sandstones.**

(7) Ca. eight meter thick **brownish siltstones** were only found in one section to the NE of Flachau, intercalated within gray-brownish sandstones.

In summary, the overall clast/grain size decreases eastwards, where the only siltstones were found. The angularity of clasts decreases from west to east, too. Both types of observations indicate an overall eastward transport direction, largely consistent with limited ESE to SSE transport directions.

The basin infill records a pronounced climate change from subtropical to humid climate due to color change from red to gray. This change can be used as a proxy for approximate dating as a similar, regional climate shift has been reported, e. g., from early Miocene deposits in the Styrian basin. The lithofacies evolution shows a rapid subsidence and infilling by initially fluvial, massive, coarse-grained conglomerates. Later, the infilling is represented by mica-rich immature sandstones deposited in a lacustrine prodelta environment.

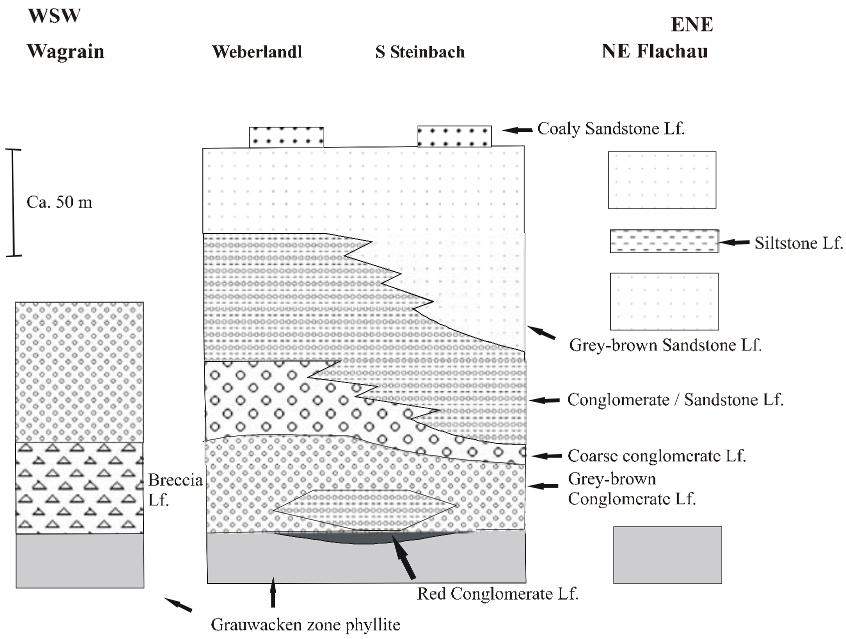

Fig. 2. Ca. ENE-WSW oriented lithofacies section of the Wagrain basin displaying vertical and lateral variations of lithofacies types. Horizontal and vertical sections are not to scale.

Provenance analysis

The basal breccia mainly comprises phyllite and quartz, beside a low proportion of micaschist and gneiss pebbles. The red conglomerate lithofacies is dominated by quartz, pegmatite gneiss and orthogneiss pebbles and boulders. The gray-brown conglomerate lithofacies is dominated by quartz, pegmatite and aplite gneiss and mica-poor, light-colored orthogneiss and augengneiss. Among these, orthogneiss and foliated pegmatite gneiss are particularly abundant components. Quartzitic micaschist, grayish and light-colored laminated/foliated mylonitic quartzites, garnet-rich paragneiss, plagioclase amphibolite are further medium-grade metamorphic components. The gneiss clasts are similar to such exposed in the Gneiss-Amphibolite Association of Schladming and Pölsenstein massifs. Serpentinite is possibly from Hochgrößen, and greenschist, black lydite, and dark phyllite are from low-grade metamorphic successions of the underlying Grauwackenzone. Subordinate are Werfen-type red sandstones from the Northern Calcareous Alps. Sandstones are classified as orogenic sources according to the Dickinson-Gazzi method (Fig. 3). The proportion of white mica is extremely high, reaching values of ca. 30 percent among framework constituents. Biotite is

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abundant, too, in lithofacies (3) to (7), and absent in basal red sandstones underlining their climate-controlled preservation.

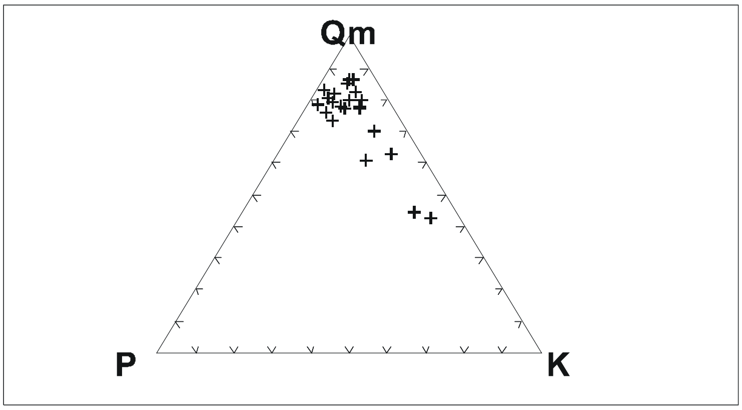

Fig. 3. Sandstone composition according to Dickinson-Gazzi method

Structure

Palaeostress tensor orientations deduced from faults within the Wagrain basin allow distinguishing (Fig. 4): (1) a palaeostress tensor group A comprising E to ESE dipping normal faults, which indicate WNW-ESE extension, and (2) a palaeostress tensor group B with ca. E- to ESE-trending dextral strike-slip faults, which can be explained by E-W contraction (see also Wang & Neubauer, 1998). In metamorphic basement rocks and Mandling wedge, three stages of deformation are particularly common and include: (1) **Deformation stage D_1** comprises ENE-trending sinistral faults, which are formed by NE-SW compression. (2) **Deformation stage D_2** includes normal faults due to N-S extension. (3) **Deformation stage D_3** displays ENE-trending dextral and N-trending sinistral faults, which were activated within E-W contractional conditions.

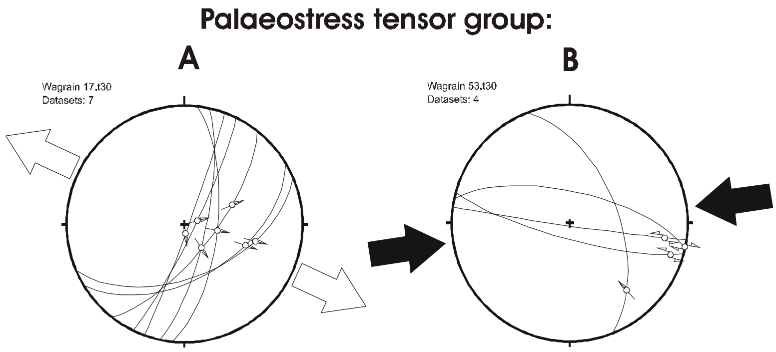

Fig. 4. Representative examples of palaeostress patterns deduced from faults within the Wagrain basin

Conclusions

The data presented above show that the Wagrain basin formed along the merging of two major regional, nearly orogen-parallel sinistral Salzach-Enns and Mandling faults. Together with the overall antiformal structure of the Graywacke zone, this could indicate that the Wagrain basin is exposed in a sort of a halfgraben along the sinistral transtensional Salzach-Enns/Mandling fault system and correlate with the Augenstein landscape covering the whole eastern part of Northern Calcareous Alps and Central Alps (Frisch et al., 1998). The sediment transport direction is mainly from the N and W, which argues for a topographic gradient and the presence of a growing fault system. The transtensional nature of the Wagrain basin contrasts with some other intramontane basins of the Eastern Alps which are generally interpreted to represent pull-apart- and transcurrent basins along major strike-slip faults (e.g. Ratschbacher et al., 1991). The Wagrain basin is obviously not controlled alone by pure strike-slip faults but normal faults, which indicate transtension oblique to the motion direction of the extrusional wedge.

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References

EXNER, Chr., 1996: Leitgesteine und Tektonik in Phylliten bei Wagrain und Radstadt (Land Salzburg). – Jb. Geol. Bundesanst. (Wien), 139: 155 – 190.

FRISCH, W., KUHLEMANN, J., DUNKL, I. & BRÜGEL, A., 1998. Palinspastic reconstruction and topographic evolution of the Eastern Alps during late Tertiary tectonic extrusion. Tectonophysics, 297, 1-15.

RATSCHBACHER, L., FRISCH, W., LINZER, G. & MERLE, O. (1991): Lateral extrusion in the Eastern Alps, part 2: Structural analysis. – Tectonics, 10: 257-271.

WANG, X. & NEUBAUER, F., 1998. Orogen-parallel strike-slip faults bordering metamorphic core complexes: the Salzach-Enns fault zone in the Eastern Alps, Austria. J. Struct. Geol., 20: 799-818.